CHICAGO ENGINEERING REVIEW

The Monthly Publication of the L. L. Cooke School of Electricity

Vol. IX, No. 1-2 MAY—JUNE, 1928 Price 10 Cents

Don't Pay For Your Fun With Your Future

A Heart to Heart Talk by the Chief on the High Cost of Summer

HOW much does Summer cost you?

You may think that Summer is free—that it doesn't cost you a cent to have it and to enjoy it. And, it's true, you don't have to pay anybody any money for the privilege of the delightful days that are just ahead.

Stop and think a moment, though. Summer is the time when everyone tends to ease up in their work. "Put it off" and "What's the use of sweating your head off—come on and have a good time" are the temptations that we all know. Outdoor sports—baseball, swimming, motoring, camping—all are far more tempting than study and work. So, often and often, Summer is a time of neglected and wasted opportunities. And when it is, when you pass up chances to improve yourself in your job and to prepare for a Big Pay position in Electricity, then I say you are paying a mighty high price for Summer.

Enjoy yourself—sure! Take full advantage of the warm weather to indulge in health-building games and sports. Mix a little play with your work. BUT—don't pay for your fun with your future!

There are just as many opportunities, just as many open doors to success, in July as in January. The work of the world goes right on. People eat, dress and live just as well, season in and season out. The great public utility plants, the electrical equipment factories, go right on producing, whether the thermometer reads 95° or 35°. Nature is busiest in the Summer, preparing a bountiful harvest for the Winter months. You, too, should be preparing, never letting up in your efforts, because when Opportunity calls—you must be ready!

In the great World War, the tide of battle swayed back and forth across northern France and Belgium for four years. Neither side could break through to victory. Then came the scorching Summer of 1918, when the Germans massed all their forces in three terrific drives at the Allies' lines. Millions and millions of men were hurled forward in that desperate attempt—but the Allies were ready. Hot weather didn't cause them to relax their watchfulness. And on the heroic fields of Chateau Thierry, Belleau Wood and Amiens the greatest conflict of all time was won for the Cause of Right!

My friends, you will have battles to fight; the grim enemies, Failure and Poverty, to overcome—for Success comes only to those who deserve it. And I say to you frankly, you cannot afford to slacken your efforts. June, July and August are full of fine-sounding excuses for not studying, for taking things easy. But for the sake of your future in Electricity, turn a deaf ear to them. Time lost is money lost and opportunity lost.

Don't pay for your fun with your future this summer.

L. L. COOKE.

RADIO Direction Finder

A Modern Aid to Navigation

Installation of Radio Direction Finder on deck of vessel.

THE radio direction finder, which is a device designed for installation in the chart room or pilot house of a vessel, has greatly increased the safety of navigation. By means of the direction finder, accurate radio bearings may be taken on radio beacon stations of the United States Bureau of Lighthouses, or on any radio shore station or ship. Bearings taken with the radio direction finder during thick or foggy weather are fully as accurate as sight bearings in clear weather. They may be used in navigating and locating vessels in all respects the same as sight bearings. By taking cross bearings on two or more radio stations, the position of a ship may be accurately determined. Or, the radio signal may be used as a leading mark, for example, to enable a vessel to make a light ship anchored in the approach to a harbor or to pass outside of lightships anchored at dangerous points along the coast. The direction finder is shown in Fig. 1 and examples of its use are given in Fig. 2.

The radio beacon stations shown in Fig. 2 are located on selected important lighthouses and light vessels along the coast. They are equipped with apparatus for sending radio signals of simple and easily recognized characteristics during the continuation of fog or thick weather, by means of which the navigator of any vessel provided with a radio direction finder may take definite bearings to guide or locate his ship, although no object is visible. Bearings may also be taken on any suitable radio communication stations which are operating, as well as bearings of other vessels which are using their wireless transmitters. In addition to the value of the direction finder during fog it may be used in clear weather for taking bearings beyond the limits of visibility whenever this is desirable. Bearings may be taken with the radio direction finder at any distance up to several hundred miles.

The direction finder consists of a rotatable loop aerial arranged for outside mounting above the chart room or pilot house, connected by a shaft passing through the deck to an indicating device, which allows bearings to be taken directly from a compass card or gypro repeater. Interposed between the loop and the indicator is a novel form of mechanical compensator which automatically provides the necessary correction to offset errors introduced on account of metal objects aboard the ship. The wires leading down through the

shaft from the loop aerial are connected to a receiver - amplifier mounted in the base, the entire instrument being self-contained in one unit.

The loop itself consists primarily of a number of turns of wire enclosed in tubes joined together to form a square. This container, which is watertight, is mounted on one corner with its plane vertical and supported on a pedestal by means of which it is raised above the deck. The shaft from the loop passes through the deck down into the room below. The loop rotates on ball bearings, swinging quickly and easily from one position to another when the hand wheel is turned. The hand wheel is located in the room below the loop, being mounted vertically and geared to the loop shaft with a two to one reduction. This method of mounting the wheel has marked advantages, one being the ease of handling the loop in a gale, due to the reduction gear between the control wheel and the loop shaft, and another being that the rolling and pitching of a vessel does not interfere with the manipulation of the loop while taking a bearing.

Fig. 1. Showing location of radio beacons.

The automatic compensator has been designed so that it may be quickly and accurately adjusted to correct variations up to plus or minus twenty degrees every 45 degrees. After the instrument has been calibrated and the compensator adjusted, accurate readings may be taken directly from the indicator.

The indicator supplied with the instrument consists of a dumb compass card, mounted so that readings may be taken in degrees from the ship's head, or the card may be adjusted so that bearings may be taken relative to the meridian. This card is illuminated from below by a small light concealed in the base. Bearings are read by means of parallel lines engraved on a piece of plate glass, which revolves above the compass card as the loop is turned. A reading glass may be used to enlarge the scale on the compass card, a suitable glass and mounting for same being supplied with each instrument. On ships equipped with a gyro compass the dumb compass card may be replaced by a live gyro repeater.

The receiver-amplifier is of the superheterodyne type, with tuning controls calibrated for quick and easy adjustment to the wavelength desired. All receiver controls are arranged on a small slanting panel at the top of the pedestal casting, and are within easy reach while operating the instrument. A storage battery is used for filament

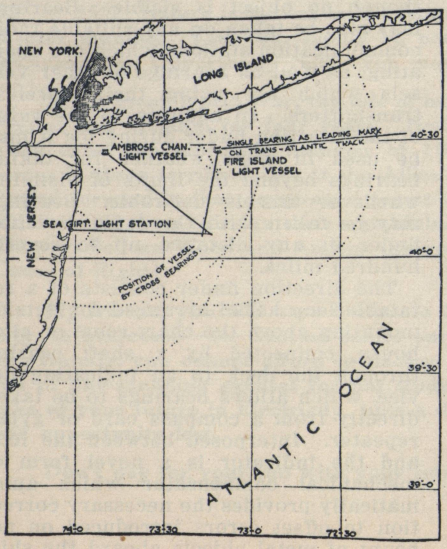


Fig. 2. Showing method of obtaining bearings.

(Continued on page 12)

The New A. C. Tubes for Radio

POSSIBLY nothing has caused so much interest in radio as the new alternating current tubes, but engineers have been working on this development for a long time so the idea is not exactly new.

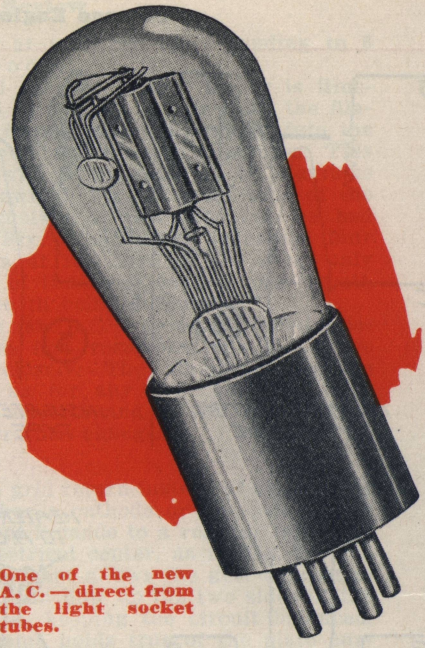
The development of the new tubes is a triumph of refinement and not so much the discovery of a new idea. Perhaps it would be better to say "Perfection" rather than "Development" when speaking of A. C. tubes.

Some difficulties are yet to be ironed out, but in general these tubes are a success. Almost everyone is willing to tolerate a little hum in order to avoid the use of storage batteries and the attention that must be given a battery operated set.

Heater and Raw A. C. Types

All A. C. tubes can be divided into two types, namely, heater tubes and raw A. C. tubes. In the heater type, electron emission is brought about by a cathode which is brought to red heat by an alternating current filament located inside the cathode. This cathode is massive compared to the filament and is therefore insensible to sudden changes of temperature.

The cathode or emitter, is coated with an oxide which gives off electrons at a relatively low temperature as compared with the tungsten filament so commonly used in D. C. tubes of the 201-A type.



One of the new A. C. — direct from the light socket tubes.

One kind of heater type tube is shown above and the symbol for the tube in Fig 2. This is the Arcturus heater tube using a standard four prong base. The connections are practically the same as for any D. C. tube except that the heater element is connected electrically to the positive filament when we think of the connections as they are made on the ordinary D C. tube. Of course, there are no fixed positive and negative terminals in an alternating current circuit.

Looking at the side of the tube base which has the two filament connections,

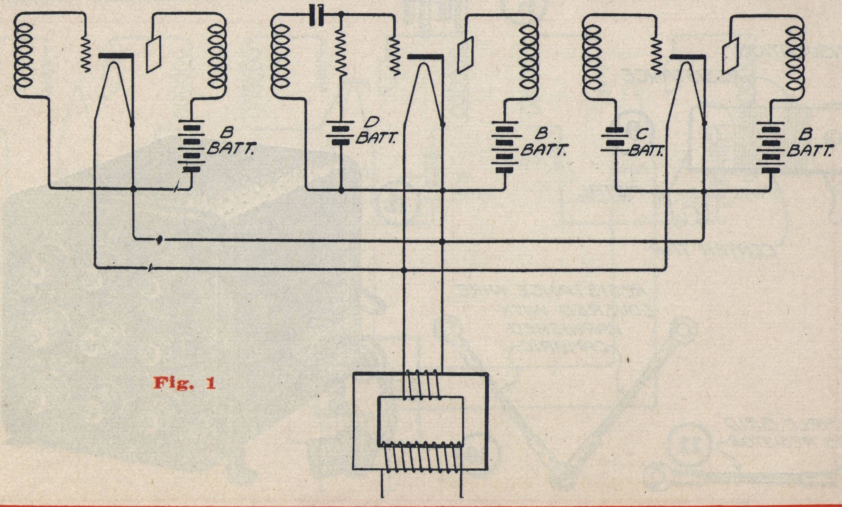
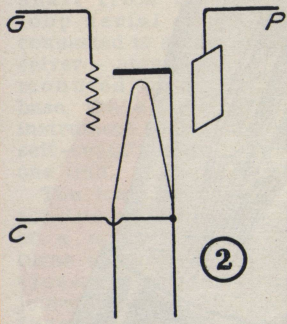
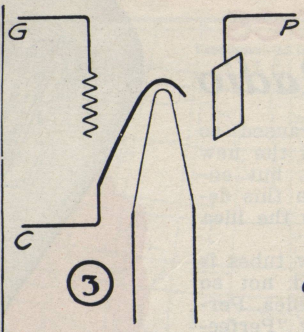


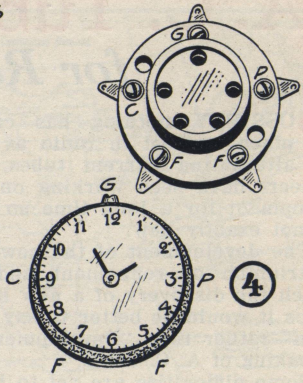
Fig. 1

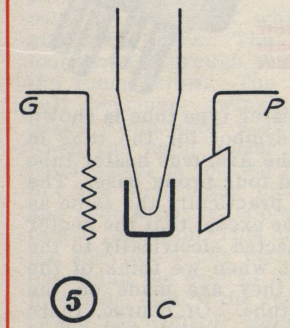


15 VOLT HEATER TYPE TUBE

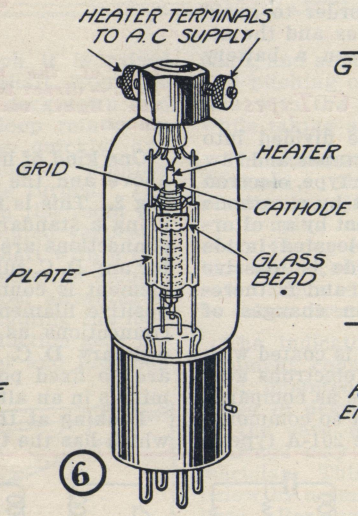


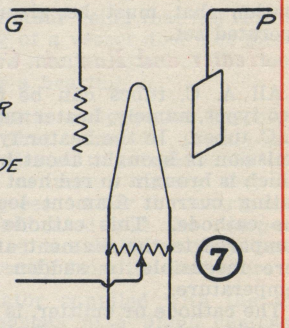
INSULATED HEATER TYPE TUBE



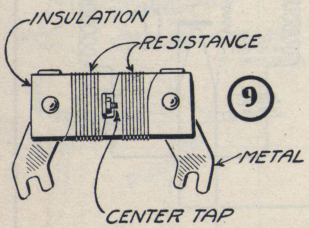


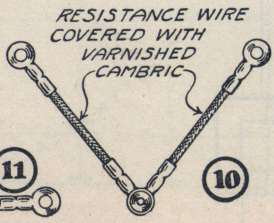
HEATER TYPE TUBE EMPLOYING OVERHEAD HARNESS

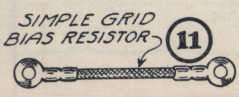


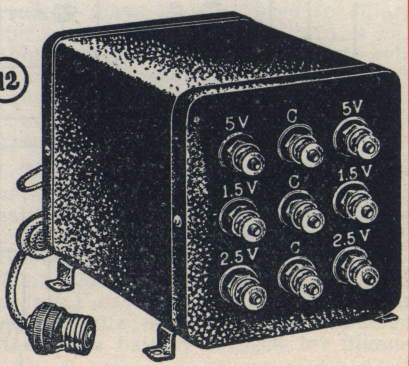


RAW A.C. TYPE TUBE EMPLOYING DIVIDED GRID RETURN









the grid return and the plate return are both connected to the right hand terminal instead of the left hand terminal as is customary in amplifier circuits. In Fig. 1 we shall see how the grid, filament and plate circuits are run in the three respective types of circuits found in a modern receiver.

At the left, we have the amplifier which may be either for radio frequency or audio frequency. Grid biasing can be had either by means of a "C" battery or a resistor connected in series to hold negative charges on the grid.

Positive Bias on the Detector

The detector circuit shown in the center of Fig. 1 has what we shall term a "D" battery for it is found that the detector gives better results if it is given a positive bias. The "D" battery gives this bias.

The power circuit shown to the right is practically the same as the other amplifier circuits except that a "C" battery of relatively high voltage is always found in the grid circuit.

Another type of heater tube is illustrated in Fig. 3. In this tube, the cathode or emitter is insulated from the filament, making an extra prong necessary. This type which is manufactured by the Radio Corporation is known as the UY227, and all sockets having five receptacles for the UY-227 tube are known as the UY socket. Some idea of this socket can be had from Fig. 4. Note the watch face shown to the right of the socket: The cathode represented by the letter "C" is to be found at a position compared to 9 o'clock while the grid is to be found at 12 o'clock and the plate at 3 o'clock. The filament connections are to be found at positions corresponding to 5 and 7 o'clock.

Still another type of heater is illustrated in Fig. 5. In this tube, the filament connections are brought into the tube overhead through a harness. This tube will be represented in diagrams as shown in Fig. 5. Some idea of the construction of this tube can be had from Fig. 6. Although there are four prongs at the base of the tube, only three of them are used in the circuit, the fourth being a "dummy."

The raw A.C. type which will be described last resembles the D.C. tube very closely. The filament looks the same as for any D.C. tube but it is more massive and is less sensitive to temperature changes.

Grid Return Connections

The grid return instead of being made to either a cathode or one side of the filament is made to a resistor tapped at its electrical center, as in Fig. 7. This arrangement allows the grid current to divide and flow up the two sides of the filament, keeping the circuit balanced. The same holds true of the plate current which must also depend on the filament as a part of the plate circuit. The raw A.C. tube as manufactured by the Radio Corporation is known as the UX-226.

Amplifier, detector and power circuits are all shown in Fig. 8. The amplifier circuit needs very little explanation except to say that the voltage of the transformer winding supplying the current is very low—1½ volts. The current taken by the raw A.C. tube is a little more than one ampere, 1.05 ampere, to be exact.

Continued on page 22)

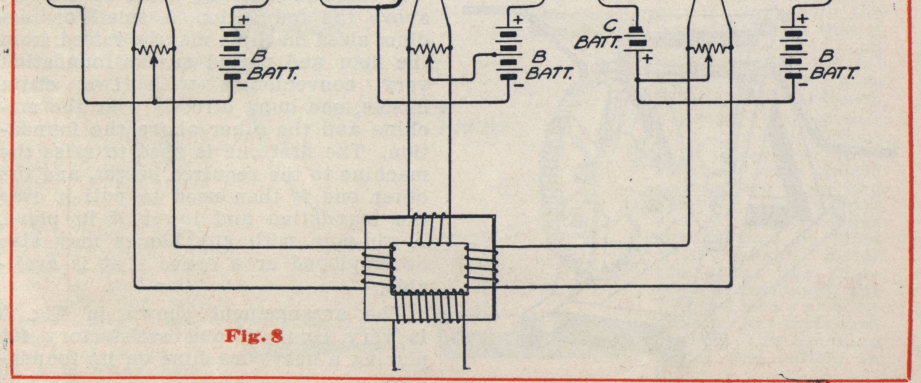


Fig. 8

Moving and Installing Electrical Machines

By Member L. L. Cooke School Staff

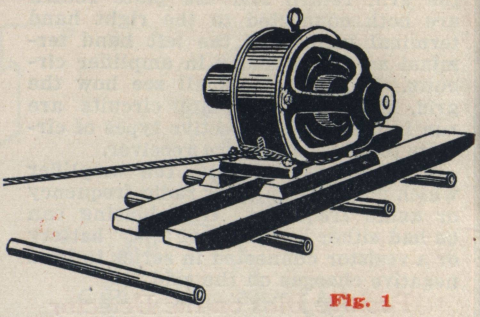


Fig. 1

SMALL electrical machines may be moved from place to place very easily, on a truck or a dolly and may be lifted on their foundations and set in place by hand, but such methods are obviously impossible with medium sized and large machines and quite often the hardest part of the entire job of installing electrical machinery is moving the equipment to the place where it is to be used and placing it on the foundation.

In Fig. 1 is shown a common method of moving a motor or generator with skids and rollers. The skids are heavy planks bolted securely to the motor base. For machines of medium size, rollers made of sections of iron pipe are suitable, but for large machines, hard wood rollers, 4″ to 6″ in diameter should be used. Unless the machine is moved over a perfectly smooth hard surface, a runway of planks must be provided under the rollers, to permit them to turn easily and prevent them from sinking into the ground.

Small and medium sized machines may be moved in this way by hand, or by pulling on a rope attached to the machines, but for large machines, a block and tackle or a winch as shown in Fig. 2 is necessary. When the winch is used, it is first securely anchored in place, then one end of the pulling rope or cable is attached to the machine and the other to the drum of the winch.

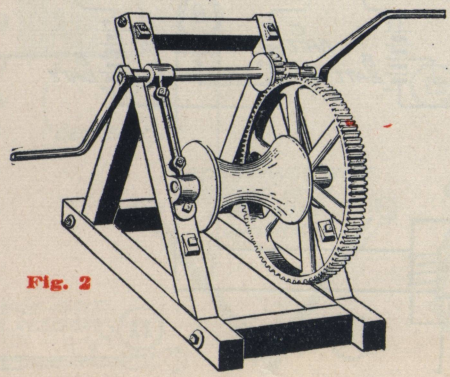


Fig. 2

When the hand crank is turned, a powerful pull is developed on the cable which is wound around the drum of the winch.

The above method is suitable for moving short distances only. If a large machine must be moved a considerable distance, a heavy trailer drawn by a truck or tractor is generally used, provided it is impossible to move the machine by rail.

After the machine has been moved to the place where it is to be used, the next problem is to place it on the foundation. This part of the installation must be handled very carefully and the machine elevated a little higher than the top of the foundation, then moved over the foundation and lowered in place, so the foundation bolts pass through the holes in the base.

The importance of using great care in this work can hardly be over-estimated. If the work is carelessly done the workmen are in danger of personal injury and the machine may be damaged. A fall of only a few inches may do so much damage to a large heavy machine that it cannot be used until it has been returned to the factory for repairs.

If there is a strong beam or support above the foundation, a small or medium sized machine may be raised from the floor and placed on the foundation very conveniently with two chain blocks, one hung directly over the machine and the other above the foundation. The first one is used to raise the machine to the required height, and the other one is then used to pull it over the foundation and lower it in place. A gin-pole with guy blocks may also be employed or a crane if it is available.

The arrangement shown in Fig. 3 is very common and satisfactory for placing a heavy machine on its founda-

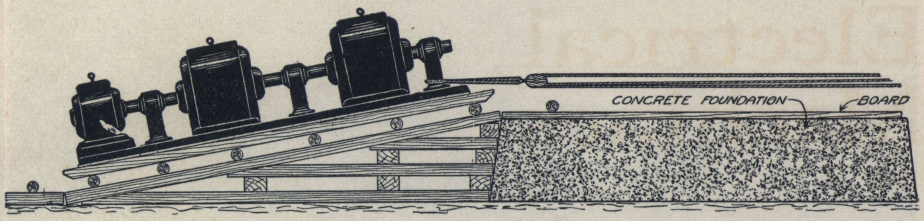


Fig. 3

tion. A slanting runway supported by a crib built of heavy hard wood about 5″ or 6″ square is arranged as shown. The machine is drawn up on the foundation with a block and tackle or a winch. When the machine is in the proper position, it is raised slightly with heavy jacks to permit removing the skids and rollers. The jacks are then lowered until the bed plate of the machine rests on the foundation.

Another common method is to place the machine beside the foundation, then build a crib under it, raising the machine with heavy jacks, as the crib is built. When the crib has been built to the correct height, the machine may be moved over on the foundation with rollers and lowered in place.

Leveling, Aligning and Fastening Electrical Machines

Placing an electrical machine on its foundation, does not finish the work by any means and the next step is to properly level and align it.

When a machine is used with a direct drive, it must be raised or lowered so its shaft is directly in line with the machine it drives or by which it is to be driven, as the case may be.

There are two types of levels used, spirit levels and surveyor's levels. The spirit level, one type of which is shown in Fig. 4, is used a great deal more than the surveyor's level. The latter is generally used only for extremely large machines. The hydrostatic level shown in Fig. 5 is often convenient, where another type is not available and it may be readily constructed as shown. It consists merely of a length of rubber hose with short sections of glass tubes inserted in each end. The hose is then completely filled with water and since the water seeks the same level in each end, it provides a fairly accurate level.

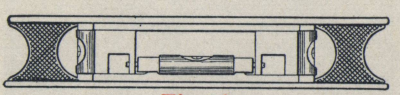


Fig. 4

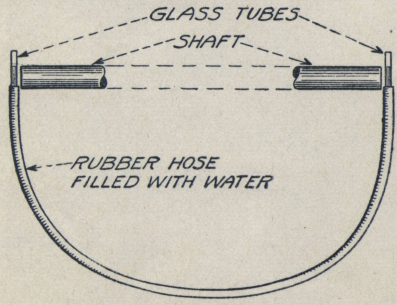


Fig. 5

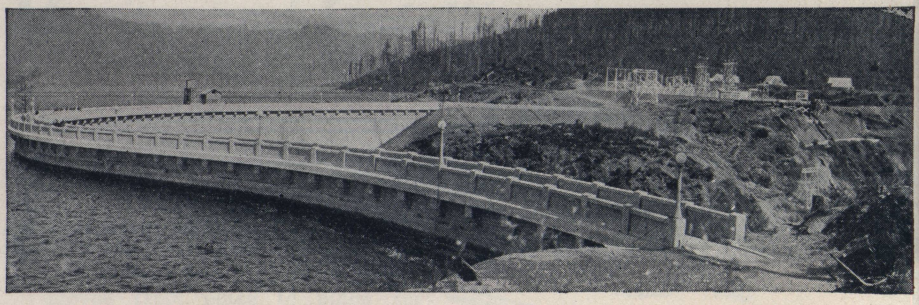
Fig. 6

Leveling wedges of wrought iron, shaped as shown in Fig. 6 are driven between the bed plate of the machine and the foundation, until the machine is perfectly level and set at the correct height. These wedges are usually from 1½″ to 2½″ in width and several inches in length. They are generally about 1½″ in thickness at one end, tapering to a point at the other. Ordinarily they support the bed plate or the base of the machine from ½″ to 1½″ above the foundation.

Grouting

The grout used to support a machine should consist of a mixture of Portland cement, clean sand and water. The mixture may consist of one part of sand to one part of cement or 3 part of sand to 2 part of cement. After the sand and cement are thoroughly mixed together, sufficient water should be added and thoroughly mixed in, to allow the mixture to flow freely. A supporting wall must be built around the bed plate of the machine on top of the foundation, either of bricks or boards and the grout then poured in around the base and worked under it thoroughly. The mixture should be thin enough so that it will flow under every part of the base freely, so that it will form a good solid support for all parts of the base after it has hardened.

After the grout has had sufficient time to set and harden, the wedges should be knocked loose and removed. The holes left by the wedges should then be filled with cement. After the grout has thoroughly hardened, the foundation bolts should be tightened to hold the machine firmly and solidly in place.



View of the dam of Skokomish Power Plant Number One

The Skokomish POWER PLANT Number 1.

[By Student George B. Haskins
Tacoma, Washington]

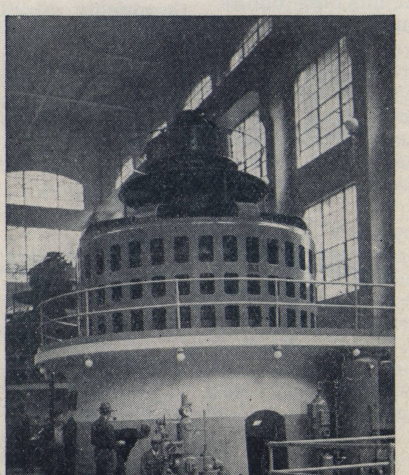
THE Skokomish Power Plant No. 1 is located on the north fork of the Skokomish River, four miles west of Potlatch, on Hoods Canal, Washington. Behind the dam towers Mount Elinor, one of the outstanding peaks of the Olympic Range. The melting snow fields from it, and from other nearby peaks, furnish a constant supply of water to the dam.

For many years a neighboring city has been interested in the development of an hydroelectric plant and after spending much time and money on investigation, finally abandoned the idea. Later, the city engineers of Tacoma, Washington became interested and plans for the dam were started as early as 1916, but the real plans that were used were not begun until 1918, when engineers of the Light and Water Department under Mayor C. M. Riddell started work on the project.

The time required for actual construction was from May, 1924 until February 1, 1926, a period of twenty-two months. The cost of the first unit, as this plant is called, was approximately $5,250,000 and in the years to come it will more than pay for itself.

The advantages that were present, all helped in the decision for the dam location. There was an abundance of sand and gravel at the site in the canyon plus a railroad built practically to the site. These added greatly to the economical construction.

The height of the dam is two hundred seventy-nine feet, maximum. It is fifty-two feet thick at the bottom and tapers up to eight feet thick at the top. The upstream radius at the bottom is one hundred eighteen feet and two hundred ten at the top. The actual length of the arch is four hundred seventy feet. The arch and the abutments equals seven hundred forty feet. The overall length is eleven hundred eleven feet.



One of the big 25,000 H.P. turbo-generators. Note the size compared with the man in the foreground.

The dam is one of the ten largest in the United States and is a type of dam known as a "Constant Angle Arch" or by its patent name, "Jorgensen Curve" dam, named after the inventor who owns the patent on it. The rights for the use of this type

of dam along with the patentee's consulting advice cost the city of Tacoma, twelve thousand dollars.

The elevation of the concrete spillway is seven hundred thirty-five feet above sea level and the width is nearly two hundred feet.

There is only one valve in the dam and it is located in the center, at the bottom, and on a level with the basin. This valve is known as a Johnson valve and is six feet in diameter. The estimated flow through the orifice when completely open is two thousand five hundred second feet of water. The storage capacity of the lake above the dam is a maximum of four hundred fifty-thousand acre feet.

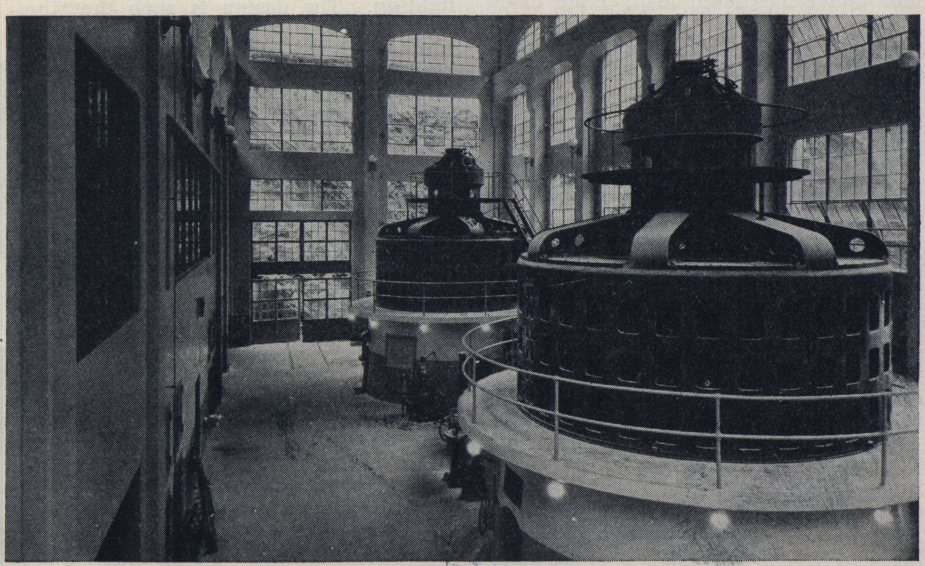
Some idea of the hugeness of the project can be imagined by the quantity of some of the materials used: Five hundred thousand sacks of cement. (Equal to a train six miles long); Eight thousand, seven hundred fifty tons of coal; Twenty-five hundred tons of Washington Clay; Two hundred truck loads of gypsum and nine hundred carloads of lime rock from a Washington quarry.

Sheets of copper were layed with the concrete to insure water cut off, and two inch perforated pipes run vertically with the joints to allow any spaces to be filled at some future date, if necessary, by forcing cement grout, or filler, into them.

There are two turbines or turbo-generators in the power house, each of twenty-five thousand horse power capacity. The weight of each one is two hundred fifty tons net. They are vertical and direct connected. Lowest on the shaft is the turbine wheel which is turned by the water pressure from the penstocks, above it is the generator and at the top is the exciter. Practically, all of the great weight of the rotor is carried on one massive main bearing.

At the substation a giant synchronous condenser is used for power factor correction. It is connected to the line by simply pressing a button and when its normal speed of twelve hundred revolutions per minute is reached it runs synchronously on the line, using very little power. In case line trouble occurs, which might injure the condenser, it automatically cuts off or breaks the circuit. When the trouble has been corrected the condenser may again be started.

Transformers at the Tacoma substation step down the voltage from one hundred ten thousand to fifty thousand volts, then to four thousand. Small distribution transformers reduce the voltage still further to two hundred twenty



View of generator room, Skokomish Power Plant Number One

and one hundred ten volts for heating and lighting purposes.

At the power plant there are seven, 6667 K.V.A. transformers, each containing twenty-one hundred gallons of insulating oil. There are six banks or groups, of three phase oil circuit breakers, each one containing twenty-four hundred gallons of oil. Equipment is provided at the plant for changing, treating and purifying the oil.

The transmission line is forty-four miles long. Thirty-nine miles are of five-eighths inch copper wire and five miles from Potlatch to the plant are of half inch copper cable. The line is double, with three cables to each line allowing either line or both to be used.

One crossing of this line is the longest single span in the world at the present date. It is 6244 feet long. The cable joins the towers five hundred feet above the water and the sag is two hundred feet above the water at the center. The cables were towed across the channel on a barge, one end made fast to one of the towers. They were pulled to proper tension by steam winches. The cables in this span are one and one-fourth inches in diameter and weigh ten and one-half tons each. They are made of standard plough steel to withstand the great strain. It is expected that they will reach about three hundred fifty degrees of heat in summer under maximum load. Each cable is made up of thirty-five strands of galvanized steel wire, specially constructed, concentric and reverse layed.

The four steel towers are each 316 feet high; 54x54 feet at the base; with tops 12x7 feet and the steel in each one weighs one hundred fifty-five tons. The anchor towers for the main towers have forty-five tons of steel in each.

The means of communication along this line is a carrier current telephone or wired wireless system. It is a modern telephone plus the utilization of radio waves. The wire from the transmission line act as a conductor for the propagation of waves between the two stations. Aerials are extended parallel to the transmission line on the same poles for thirteen hundred fifty feet. The waves do not radiate into space in every direction but follow the copper cables regardless of the high voltage.

Fifty thousand horsepower is developed by the first Skokomish unit, and recent tests made by engineers prove that the efficiency of the plant is ninety-two and four-tenths percent of the theoretical, obtained with the valve, or gate sixty percent open and with one turbo-generator set developing twenty-one thousand horse power.

The power leaves the powerhouse over six copper cables one and one-fourth inches in diameter at thirteen thousand volts. A bank of huge oil switches turn it to either line as desired, through great transformers which step up the voltage to one hundred ten thousand volts for transmission purposes.

The penstocks, when under maximum load, deliver one million gallons per minute,—each turbo-generator taking half of this amount.

There are three sub-stations in connection with this plant, one directly connected and two indirectly.

The next development of the system will be Skokomish Plant No. 2 to be built at Potlatch. Work is expected to be started in 1928.

The state of Washington has one-seventh of the potential water power of the United States, 7,871,000 horsepower of potential water generated energy or fourteen and three-tenths percent of the total in the United States.

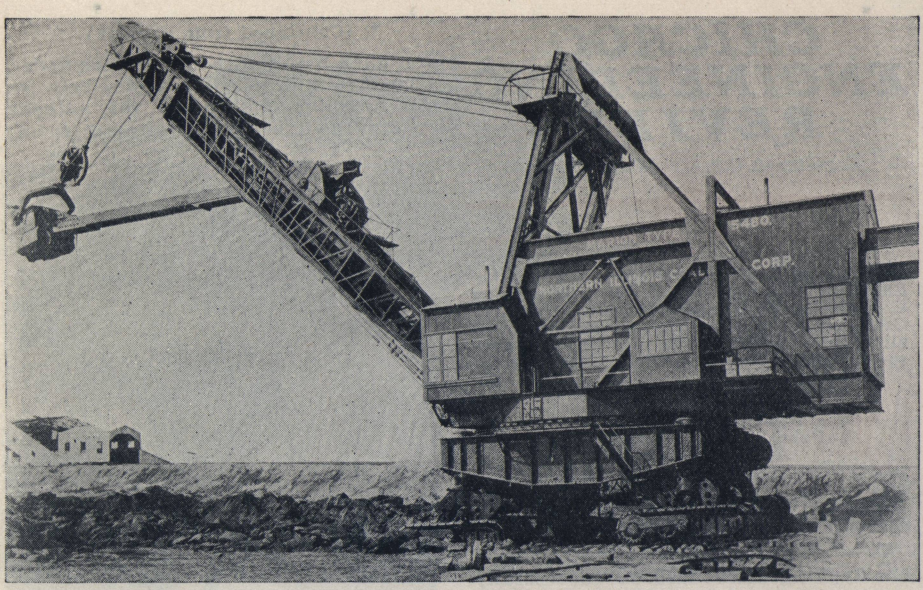
(Continued from page 4)

lighting. The design is such that the filament battery is on trickle charge when the instrument is not in use. This keeps the battery properly charged without requiring any special attention. Dry "B" batteries of the heavy-duty type supply the necessary plate voltage. A voltmeter is provided on the receiver panel for adjusting the filament voltage to the proper value and also for checking the voltage of the "B" batteries. All batteries are contained in the bottom of the pedestal casting, the entire direction finder being self-contained in one unit, thereby reducing space requirements to a minimum.

The receiver has a wave length range of 550 to 1,050 meters and, through the use of the superheterodyne principle, is remarkably sensitive throughout this wavelength range. As is well known, the superheterodyne receiver also ranks highest in selectivity, this being an important factor in the value of a radio direction finder.

Since the ship's wireless telegraph antenna must be open when bearings

(Continued on page 14)



View of the New Electric Shovel.

An Electric Shovel

That Can Bite Off 12 Cubic Yards At One Time

THERE has recently been placed in operation near Coal City, Illinois, by The Northern Illinois Coal Corporation a Type 5480 electric stripping unit, equipped with a 12 cu. yd. dipper. This machine was manufactured and erected by The Marion Steam Shovel Company of Marion, Ohio.

Heretofore, the largest standard coal stripping unit had been the Type 350 Marion equipped with an 8 cu. yd. dipper, a 90-ft. boom and a 58-ft. dipper handle. This machine operated effectively and economically in over-burden up to 40-ft. in thickness where the thickness of the coal vein averaged 5-ft. However, there is much strippable coal having an overburden not exceeding 40-ft. in thickness, but where the coal averages only about 3½-ft. in thickness. It was to operate under the latter condition that the 5480 has been developed, although its use may be extended to thicker coal with a consequent decrease in production costs.

The Type 5480 is mounted on crawling traction trucks, the arrangement being such that the machine rests on the coal, removes the overburden from the front and deposits it on the side in the section from which the coal vein has been removed.

By a unique arrangement, the lower frame is supported on hydraulic jack cylinders so that the frame really floats on a liquid. Not only does this equalize the stresses in the lower frame members, but it permits of levelling the machine as it works on an uneven coal surface.

The electric power is taken on board as alternating current and through a four-unit motor-generator set it is converted into direct current for use in driving the hoist, rotating and thrust motors. The synchronous motor of the motor-generator set is rated 700 K.V.A. and 2300 volts, the hoist, rotating and thrust generators being rated 350, 150 and 100 K.W. respectively.

Two 250 H.P. mill type direct current motors drive the hoisting drum through a single reduction herringbone gear,

CHICAGO ENGINEERING REVIEW

Registered U.S. Patent Office

The Chicago Engineering Review is a monthly Electrical Magazine, edited and published by L. L. Cooke, Chief Instruction Engineer, L. L. Cooke School of Electricity, for the benefit of all students enrolled with him for his Correspondence Course in Practical Electricity.

Copyright, 1928, by L. L. Cooke School of Electricity
Printed in the U. S. A.
Published at 2154 Lawrence Avenue, Chicago, Ill.

Vol IX, Nos. 1-2 May-June, 1928

the type of drive used so successfully on large mine hoists. The hoist bearings are piped and lubricated by the flood system, the oil being pumped by a small electric pump located on the deck of the shovel.

The rotating motion is driven by two 125 H.P. motors, one toward each of the front corner of the upper frame. This is a unique development, all shovels heretofore having been equipped with a single rotating motor.

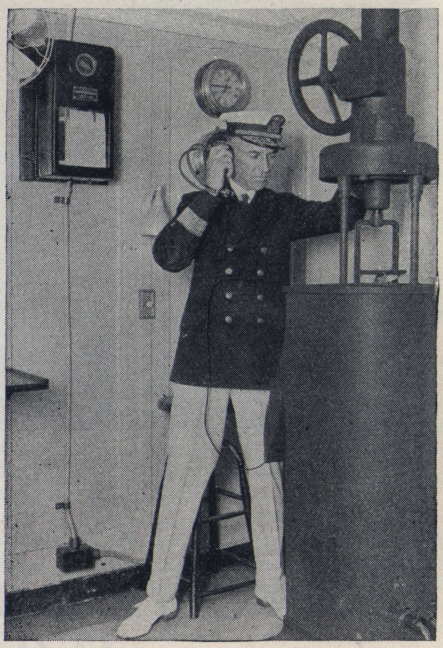
The boom is 90-ft. in length and the dipper handle 60-ft. The thrusting motor which moves the dipper out and in has a rating of 150 H.P.

Ward-Leonard control is used on all motions. The strength and polarity of the generator fields are controlled by the operator through controllers to increase or decrease the motor speeds and to change the direction of rotation. Differential series fields are incorporated in each generator field, thus inherently limiting the motor speeds under varying loads and definitely establishing the maximum torques under stalled conditions.

The working weight of the machine is 833 tons and the height of the top of the gantry is approximately 60-ft. from the ground level. While the machine is capable of handling a larger output over short periods of time, it is expected under normal conditions to handle from 2 to 3 million cubic yards in a calendar year, based on experience with the smaller stripping units.

(Continued from page 12)

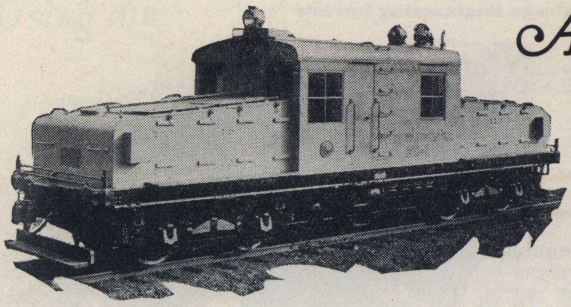
are taken with the radio direction finder, a positive interlock is provided between the direction finder and the antenna opening switch in the wireless room;



Ship's officer obtaining ship's exact location with Use of Radio Direction Finder.

also a signal light to notify the wireless operator when the direction finder is being used.

The operation of taking bearings consists of listening to a radio signal with head phones and rotating the loop by means of the hand wheel until the strength of the signal from the station on which bearing is being taken falls to zero. The bearing may then be read directly from the indicator. This gives the line of direction. In the event that the side from which signal is coming is not definitely known, provision is made for quickly and definitely obtaining a unilateral bearing or "sense" of direction. In ascertaining the sense of direction a small single wire antenna is used and the loop is swung through 180 degrees to determine which side gives the louder signal. Provision is made for plugging in two pairs of head phones so that bearings may be observed simultaneously by two persons and instruction may be given in the use of the instrument. The sensitivity of the receiver and strength of signals may be adjusted as desired.



A 17 Ton Battery

For This Montana Mine Locomotive

DID you ever hear of a battery weighing 17 tons? Perhaps not; no doubt you think of the average automobile battery whenever the word "battery" is mentioned, and after all, it is hard to imagine one of this type weighing as much as 17 tons.

Out in Montana at the town of Coalstrip, lies a bed of coal 28 feet deep, which has been waiting ages for some one to take away "stored up" energy. This bed is 180 acres in extent and contains a grade of coal which slacks very quickly when exposed, consequently, it must be removed in the shortest possible time.

Trolley Type Not Suitable

Ordinarily, trolley type locomotive would be chosen for this kind of work, but operating conditions made this inadvisable. As the coal must be loaded by means of electric shovels it is at once seen that a trolley wire would offer a serious disadvantage, so some one advised the use of a battery locomotive.

Then the time came for some very level-headed thinking. At least 6 or 8 hours were needed for charging the batteries. It would have been a mighty big job to remove the 17 ton battery every day in order to keep the locomotive in operation 24 hours a day. So engineers of the General Electric Company and the Electric Storage Battery Co. (Exide), worked out a scheme whereby the batteries could be charged without removing them and at the same time keeping the locomotive at work.

Batteries Charged on the Job

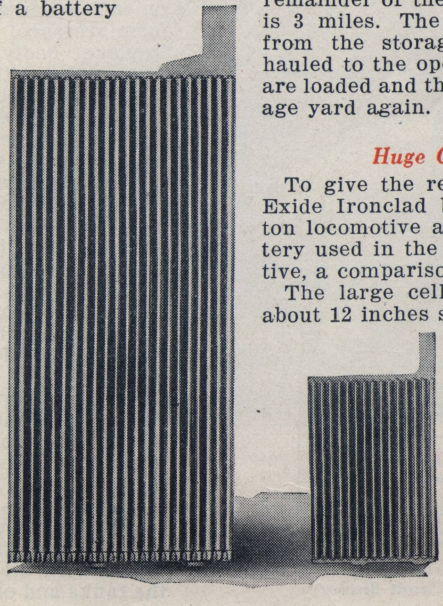
When the cars are being loaded by the shovels, the locomotive is traveling within only short limits and cables connect the batteries to charging apparatus. Thus the batteries are replenished and the locomotive takes care of its work just as easily as a trolley locomotive can do it. The charging cables are automatically payed out or reeled in as switching is done. When the cars are unloaded, the batteries are again charged.

By charging the batteries during switching service, the number of locomotives necessary are kept to a minimum. It takes about 1½ hours to "spot" the cars and the amount of charging current that can be sent through the batteries is sufficient to charge the battery so the locomotive can complete the remainder of the trip. The average trip is 3 miles. The empty cars are taken from the storage yards at Coalstrip, hauled to the open pit mine where they are loaded and then returned to the storage yard again.

Huge Cells Are Used

To give the reader some idea of the Exide Ironclad battery used in the 70 ton locomotive as compared to the battery used in the ordinary mine locomotive, a comparison of plates is shown.

The large cells are 3 feet high and about 12 inches square. Each cell has a capacity of 1,800 ampere hours at the six hour discharge rate, and is designed for a maximum current of 4,333 amperes.



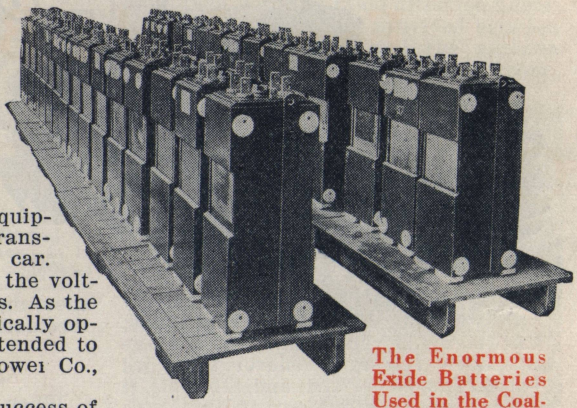
Left—Comparative Size of Plate Used in 17-Ton Battery and Average Storage Battery Used for Mine Locomotives.

This enormous size makes it possible to keep the locomotive in continuous operation.

Charging Equipment

For charging a motor generator set is used consisting of a 440 volt A. C. motor and a 250 volt D. C. generator. This equipment is supplied by a set of transformers mounted on a trailer car. These transformers step down the voltage from 2200 volts to 440 volts. As the entire Coalstrip mine is electrically operated, a 55,000 volt line is extended to Coalstrip from the Montana Power Co., located at Billings.

There is no doubt as to the success of the battery locomotives at the Coalstrip mine and no doubt that this wide departure in locomotive engineering is going to influence and encourage further progress in the mining industry.



The Enormous Exide Batteries Used in the Coalstrip Mine Locomotive.

Photos by courtesy of Electric Storage Battery Co. (Mfrs. of Exide Batteries), Philadelphia, Pa.

How to Maintain and Inspect Oil Circuit Breakers

(1) Be sure that the breaker is disconnected from all power lines and that the operating circuit is also disconnected.

(2) Look over the operating mechanism at regular intervals and lubricate all bearings with a good quality of sperm.

(3) Keep the bearings of all toggles, levers and rods oiled. A breaker will not operate satisfactorily with sticky bearings.

(4) Keep all mechanism clean.

(5) See that the contacts are properly aligned.

(6) Be sure that contact surfaces bear on each other with a firm and uniform pressure.

(7) Replace badly pitted contacts; smooth down the surfaces with a file if not in too bad condition.

(8) Be sure the breaker frame is dead before you lower the tank to examine the contacts.

(9) Ground the breaker frame.

(10) See that all bolts and cotter pins are tight.

(11) Examine the insulator bushings. If loose, the contacts may get out of line.

(12) Clean the bushings of all dust or other material to avoid flash-overs.

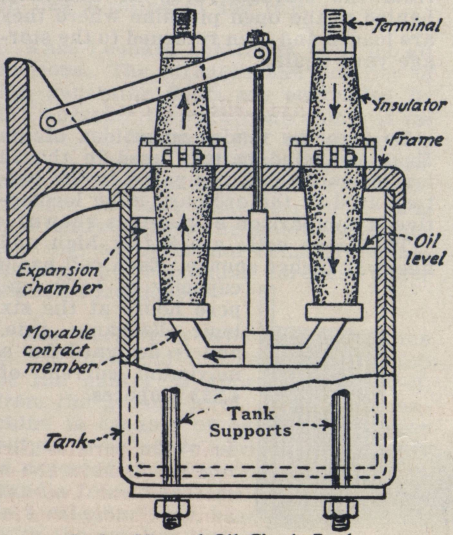
(13) Keep the oil level at the proper height.

(14) Filter the oil every six months.

(15) Look for signs of carbonization due to shorts and overloads. Carbonization is indicated by a flaky material which floats in oil when it is disturbed.

(16) Don't let moisture come in contact with oil when it is being filtered.

(17) Remove the oil once a year; clean the tanks and outer lining.



Section View of Oil Circuit Breaker

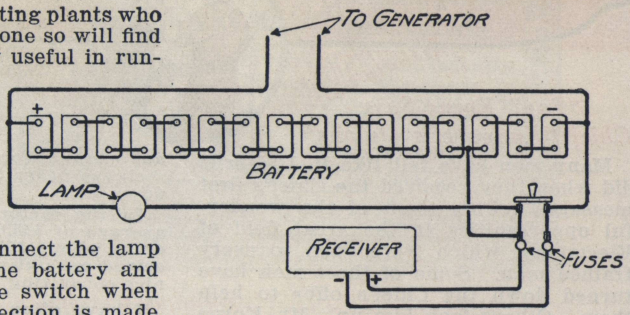
Using the

Farm Light Battery

as a Filament Supply

OWNERS of farm lighting plants who have not already done so will find the following very useful in running the radio set from the farm light battery.

First provide a double pole switch, a pair of fuses, a lamp receptacle, a lamp and some No. 14 wire. Next select three of the end cells as the filament supply. Then connect the lamp to the positive side of the battery and to the "dead" side of the switch when open. Be sure this connection is made to the side of the switch connected to inside tap.

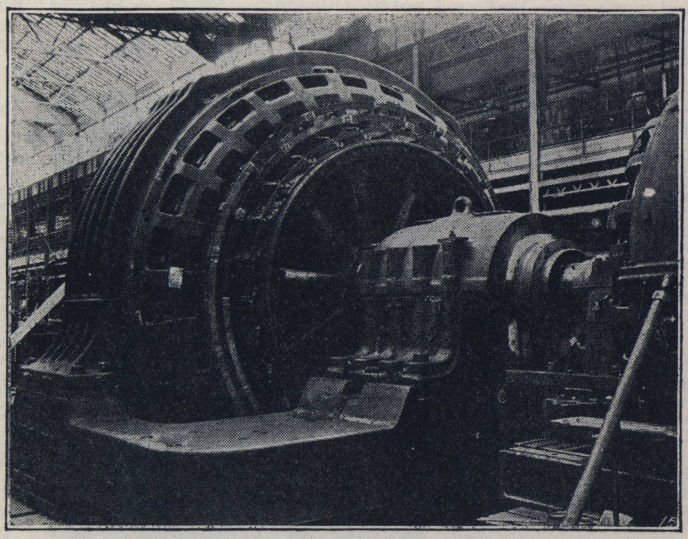


The lamp serves but one purpose; to discharge the unused cells in the same proportion to the rate of discharge of the three cells supplying energy to the radio set. By knowing the capacity of the tubes it is an easy matter to determine the discharge rate. Then knowing the wattage of the lamp and dividing by the voltage, which in this case is 32—6=26 volts. Thus a 25 watt lamp would require about one ampere and would correspond to a set having four 201-A tubes.

World's Largest D. C. Motor

THE world's largest direct current motor of 18,000 horsepower capacity has been shipped from the Westinghouse Electric and Manufacturing Company's plant at East Pittsburgh.

The motor has a total weight of 625,000 pounds. The overall length of the shaft is 26 feet 8 inches and the frame has an outside diameter of 20 feet. It is capable of developing a maximum capacity of 2,400,000 foot pounds which at 40 RPM is equivalent to 18,300 H.P.



The Motor Ready for Shipment.

The motor obtains its power from a fly-wheel set which consists of two 3,500 kilowatt, 700 volt generators operating at 375 revolutions per minute. Three 50,000 pound flywheels are used to equalize peak loads. The set is driven by a 5,000 horsepower induction motor. The overall length of this set is 48 feet 8 inches.

The BEST TRAINING Brings the BEST JOBS

Cooke Trained Men are "Putting it Over" in Every Branch of Electricity

—And the Same Training that Boosted Them Will Boost You, Too

"Pop" Korns Says Chief "Knows His Onions"

Many men have felt like R. L. Korns did when they received the Chief's first messages telling them of the wonderful opportunities in the great field of Electricity, which were open to every trained man. Some of these men have turned down the Chief's offer to help them. Others took him up. Mr. Korns was one of the second group. Now like thousands of others he wants to shout from the house-tops, and tell the whole world just what Cooke Training has done for him. Just read his enthusiastic letter.

Dear Chief: Newkirk, Okla.

In 1924 I received a book entitled "Vital Facts" and like a lot of others I just thought that it was another scheme to get my money. In a few days I received a leter and it, like the book made no impression on me. After I had received a couple of more letters and some more leaflets I got to thinking that there might be something in this after all and I investigated and had a letter from a former student.

At last I enrolled in the L. L. Cooke School of Electricity. I received my first lessons and was struck by the simplicity of them. I also received a letter from you, in it you told me that you wanted to be, not only my instructor but my friend. I, like a lot of other fellows, thought that it was a lot of "bull." Time went on and the lessons came more and more interesting and I began to see that all that you had told me were FACTS.

I began to realize that here was a man who meant to get me out of the rut and he "knew his onions."

Up to that time, I had been in the Goodyear Tire and Rubber Co.'s plant at Akron, Ohio, for eight years and a lot of the fellows there knew me, and there are still lots there that remember me as "Pop Korns."

R. L. Korns

I finally finished my course and came out to Oklahoma on my vacation. While here I saw an opening for an electrical expert. I resigned from the Goodyear and settled down here.

In the factory I was getting on the average of $35.00 a week, and now I average about $75 per week and have received as high as $25 per day. I have a nice consulting electrical expert business.

I have often been asked if I thought that the electrical business pays well. I will just leave the answer to your own judgment.

Yours very truly,
R. L. KORNS.

Wants Friend Enrolled for Cooke Training

Every year more than one hundred new students come to the Chief unsolicited. Their friends who know the value of Cooke Training send them in, because they want to do the other fellow a good turn.

Dudley, Pa.

Dear Mr. Cooke:

I want you to write and explain your Electrical Course to Mr. Milford Kyler, Dudley, Pa. I am almost sure he will enroll with you. He says he wants to learn a trade, and being an electrician myself, I told him what your Course has done for me. I have everyday work and have had for seven years. I get $200 a month and at the present time, I am wiring a hoist machine engine and working with 2300 volts. I have about 3 mines to keep the electrical parts in repair. I can hold this job all because I have an L. L. Cooke Certificate.

I am always a booster for C. E. W.

Yours very truly,
J. WAUGERMAN.

Gets Position with Northern States Power Co.

With his training only two-thirds finished, Everett Manthey has already stepped into a good position with a large power company, and making good in every way. Note what he says about the practical side of this training.

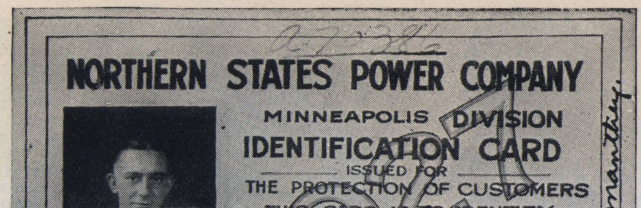
2915 James Ave., S.
Minneapolis, Minn.

Dear Chief:

I have just finished my 50th lesson and am already on the road to a better position. Through the aid of your Course I have bettered myself in many ways. I have secured a position as Electrician with the Northern States Power Company of Minneapolis, Minn.

Your Course is the best Schooling you can find any place in the World today. It is real practical knowledge something that can be used in everyday Electrical work.

I am a Booster for you and always will be. Your friend and student,
EVERETT C. MANTHEY.



Employes Identification Card with photo of Everett C. Manthey

Chief Engineer of Large State Hospital

Without any schooling whatever Cooke Training has helped L. C. Williams advance to the position of Chief Engineer. Working with electricity before beginning his study he was frequently stumped in his work and had to ask for help. But not so now. Cooke Training changed that and now he knows.

403 East Main,
Norman, Oklahoma.

Dear Mr. Cooke:

I want to give you a brief summary of the amount of machinery than I have under my charge. We have over $200,000 worth of machinery most of it is electrical, such as, Alternaters, D. C. Generators, Electrical Pumps both single phase and three phase motors of all descriptions. Voltage at different pressures, such as: 2,000, 440, 220, and 110.

I have been handling electricity for fifteen years at various places and have been up against some very difficult problems in regards to trouble shooting, etc., and have had to call for assistance many times, but since taking your Course I have never had to ask anyone to help me up to this hour.

I want to say one of the good features about your Course is that it helps a fellow with a limited education like myself for I never went to school a day in my life. When I started your Course you gave me encouragement and inspired me to dig in harder. With hard study and your help, I have come through fine. Your course has been worth the money I paid for it many times over.

Wishing you and your staff many happy returns of the day and always will be a friend of and a booster for your school. Thanking you for past favors, I remain yours Sincerely,
L. C. WILLIAMS.

P. S.—I now hold the position as Chief Engineer of the Central State Hospital of Oklahoma. I have eight assistants working under me at this time.

Boss Sees Diploma—Cherry Gets Raise and Promotion

Many a Cooke Trained man has been pushed right up into a better job and handed a bigger pay check, just on the strength of his training. The face value of an L. L. Cooke diploma is tremendous. Thousands of employers consider this diploma the best "letter of recommendation" a man can have.

2919 S. Michigan Ave.,
Dallas, Texas.

Dear Chief:

Will drop you a few lines to let you know that I have got a $24.00 raise and a promotion, I leave in the morning for Midland, Texas, which is about 350 miles from Dallas. The job is on a 12 story office building. I am not going to run the job, because I am nothing but a kid you might say, for I am only 19, but your wonderful course has made me a better electrician than a lot of men that claim to be electricians.

Chief, I just have to make good on this new job for this is my first big chance, but I sure feel confident, with the excellent training you have given me.

As well as I can make it out, my Diploma is the cause of my promotion for nothing had ever been said about letting me go out on a job until one day when I showed the boss my Diploma. I noticed he eyed me sort of funny, and in a few days he asked if I would go on this job, and you can guess the rest. I had been driving a truck and keep stock and just such odd jobs as that.

Believe me I sure am happy to get an opportunity to get on a real job like this one. Well, Chief, thanks to you.

Yours forever, R. B. CHERRY.

Edwin E. Peet

$2.50 a Day Man—Now Goes as High as $20 a Day

Ed. Peet made $2.50 a day doing simple electrical work before taking up the Chief's Course. After completing it he makes many times his old salary and goes as high as $20.00 a day. $2.50 a day is what a man can earn with his hands. $20.00 a day is what he gets for using his head. Ask Ed—he knows.

R. D. No. 1,
Middletown, N. Y.

Dear Mr. Cooke:

When I enrolled for your course in Practical Electricity I could wire door bells and put in simple light circuits, but I had no knowledge of general house wiring or motor work.

When I left school I had an ordinary eighth grade school education.

At the time I enrolled for your Course I was earning from $2.00 to $2.50 per day. Now I make as high as $20.00 per day doing Electrical Contracting. I cannot boost the C. E. W. Course enough for what it has done for me. I know your training has benefited me and I know that it will do the same for anyone else that is ambitious enough to study the course from start to finish.

Your friend and student,

EDWIN E. PEET.

The Old Story About the Fellow Who Laughs Last

Jim Noble tells a good one here, about charging the fellow who laughed at him, double price of a little electrical job. It's an old story too, especially among those without ambition, to "poke fun" at the efforts of a live young fellow to improve himself. But who cares? Home study has made real successes out of thousands upon thousands of men. But nobody ever made a penny out of laughing at another man's efforts.

Oakland, California.

Dear Mr. Cooke:

I would like to say a word of praise for the training and knowledge I received from your Electrical Course. I have just finished what some of my friends calls the impossibility and that is mastering Electricity by mail. The more they laughed the more I studied, and my brother-in-law that had so much fun with me about my Course just paid me $10 for running a light to his garage. If it had been any one else I would have done it for $5 so you see my fun has just started.

I just have one regret and that is I wish that I had taken your course 5 or 10 years ago.

I knew nothing about electricity when I started, but I know I have gained more knowledge in the past 9 months from your Course than I could in 10 years from practical experience alone.

J. L. NOBLE.

$25 a Month Farm Hand Jumps to $75 a Week in Electricity

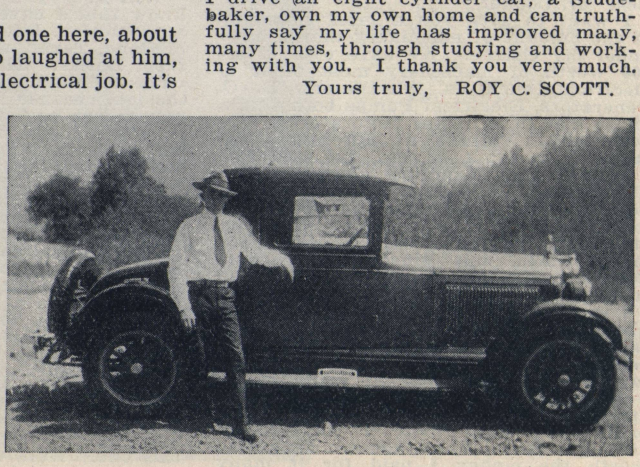
Roy Scott says to the Chief "you certainly have the goods and all a man needs to do is study and practice the things you tell him." How many of the Chief's students have found this true; how many of them have learned that Cooke Training and a willingness to apply it is the only requirement to master electricity and attain success.

81 Ninth St., Newark, Ohio.

Dear Mr. Cooke:

For a long time I have thought about writing my "Chief." But I neglected to do so. Well, here is my story. When I began taking your Electric Course I was working on a farm for about $300 a year. Today, I am working for the Delaware Power Company at seventy-five a week. Some raise? And I can thank you for it. You certainly have the goods, if a man has the gumption to study and practice what you tell him. I drive an eight cylinder car, a Studebaker, own my own home and can truthfully say my life has improved many, many times, through studying and working with you. I thank you very much.

Yours truly, ROY C. SCOTT.



J. L. Noble

Ship's Officer Boosts Home Study

The S. S. Hegira is home to D. L. Sancrant, but because his ship is on the move most of the time one would think it difficult for him to learn electricity through a "correspondence school." But read his letter. Let him tell you what he has learned about home-study. Sancrant proves that lack of school or college education shouldn't keep anyone from doing the things he wants to do.

D. L. Sancrant

S.S. Hegira,
Wilmington,
California.

Dear Chief:

I have found your course easy to learn not because it lacked in details but because everything is stated and illustrated in a manner to make it as clear as possible.

As for learning things by Correspondence, all that I have to say is that any one who can't do that the way you teach it had better stay on the farm cause they will never be able to really learn anything anyhow. I stared on a farm with a grammar school education and today I have my Federal Radio License and am an officer in the U. S. Merchant Marine. There are nine of us here who have licenses and out of the nine, there is not one college graduate and not one high school graduate. The nine of us claim to be Experts, still we challenge anyone to beat us at our own games. All thanks to you for what you have done. Your sincere student,

D. L. SANCRANT.

Letter from the Chief to His Boss Gets Caron a Nice Raise

You can't keep a trained man down. You can't keep the world from knowing that the trained man is a better man than the fellow without training. "Class" will always tell and sooner or later the fellow with training simply jumps ahead of the boys who are satisfied to plug along without study. Many times a little letter from the Chief written to a fellow's boss helps things along and hastens the recognition he receives.

The value of such a letter is plainly shown in the letter of Fred Caron. It brought him almost a $2.00 a day increase in pay, and of course, he has a right to be happy.

715 Balfe St.
Toledo, Ohio

Dear Mr. Cooke:

I want to write to you, and your associates and thank you a thousand times for opening my eyes to what there was ahead of me with only a few hours study each night. Also, for writing to my employers of my progress.

Today I reaped the first harvest from your course because your letter got me an increase of 24 cents an hour, or $1.92 per day raise. I was stepped up over five men who had been here longer than me. Two of these men laughed at me when they found out that I was taking an electrical course from you **but they did not laugh today,** when they found out that I received the top rate of pay, right over them. I suppose you receive hundreds of these letters like I am writing to you because, it makes one sit down and write you, telling you what a wonderful course you give for a few dollars. It is the biggest investment in the world, greater than government bonds because it pays 100 per cent dividends.

This is no bull, but the truth. A fellow can't sit down and write this kind of a letter just to be writing. When you feel like I do, you don't have to try to think of something to say because you can't make the pen go fast enough to keep up with the thoughts that come right up from the heart.

If it wasn't for you I would yet be in a rut, but now I've got a hand hold, and I am going to climb that ladder. You gave me my start. I know it and I am grateful enough to want to tell everybody about it.

If you ever need a letter of recommendation let me know, or if you have persons who want to know more about your course, I will always be ready to perform a little service for you by telling them about it as you have already done more for me than I will ever be able to do for you.

Your sincere friend,

FRED J. CARON.

The QUESTION BOX

Question:

A 3 H.P. 220 volt 3 phase induction motor in use in our plant, takes 60 amperes for about 20 seconds when the motor is first started. The current then drops to about 5 amperes. Is this high current at starting liable to damage the motor and is the use of a starting compensator necessary?

Answer:

A starting current of 60 amperes is not abnormal for the type of motor you have. Unless there is danger of the motor injuring the machine that it is driving, a starting compensator is not necessary. If you wish to protect the motor, you can do it by installing a double throw switch with two sets of fuses, one set of about 15 ampere capacity on the running side and the other on the starting side of a capacity of 60 amperes.

Question:

How can you tell when a generator is overloaded?

Answer:

On the name plate of any generator, you will find given the rating of the machine. This is generally given in amperes or in KVA or in KW. If the ampere rating is not given, then to determine the ampere rating, you simply divide the KVA or the KW rating by the voltage of the machine and this will give you the full load current.

An ammeter connected in series with one of the generator leads will indicate the current that the generator is supplying. If this ammeter reads more than the current value determined above, the machine is overloaded. A continued overload will heat up the generator armature windings and eventually damage the machine. However, most generators would carry about 25% overload for a period of 2 hours without seriously affecting the machine.

Question:

What is the meaning of the terms mmf. and pfd. as used in radio work?

Answer:

Capacity is measured in farads and one farad is defined as the capacity of a condenser which will take a charge of one coulomb when a potential of one volt is impressed across its terminals. A microfarad is one millionth part of one farad. A micro-microfarad is one millionth part of a microfarad.

It has been proposed that the micro-microfarad be called a picofarad and this latter word is coming into quite common use in radio work.

The abbreviation for a microfarad is mfd., for a micro-microfarad mmf. and for a picofarad pfd. You can see from the above that the abbreviations mmf. and pfd. mean exactly the same thing.

(Continued from page 7)

The detector circuit is not quite so simple. The grid circuit is from the grid, through the coil and back to the cathode. The plate circuit is from the plate, through the electron path, to the cathode, to B—, through the B battery to B+, through the plate coil and back to the plate.

Although nothing has been said previously regarding the resistor in the filament circuit of the detector, it is there so as to give the filament a positive bias. This has the effect of increasing the sensitivity of the tube. In some cases, it has been found that a negative bias on the filament has the same effect. The tube will work without the divided resistor and the bias.

The power circuit needs no further explanation. It is obvious that a higher "C" voltage is needed on account of the higher plate voltage.

Resistors

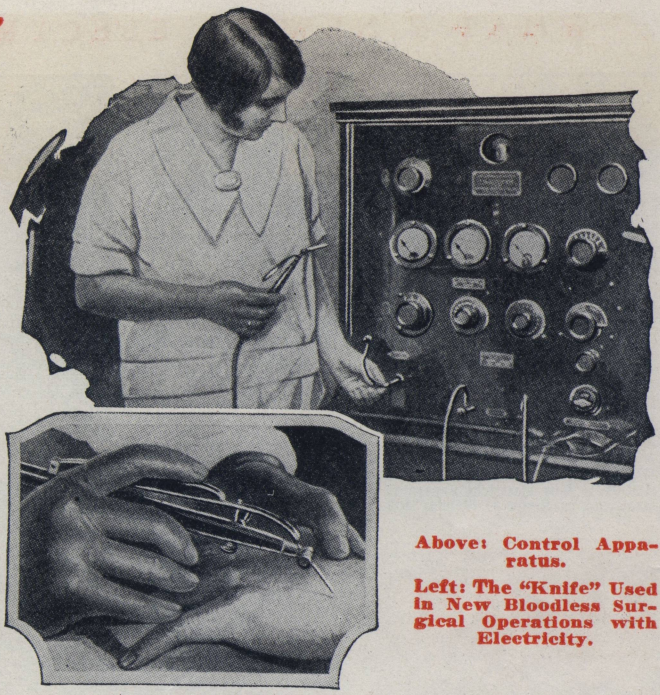
Several types of resistors are used in connection with A.C. tubes. The type shown in Fig. 9 is arranged to be clipped onto a regular socket by means of tongues which fit under the terminal nuts. Another type is the "V" arrangement shown in Fig. 10, consisting of two perfectly matched resistors. A grid bias resistor is shown in Fig. 11.

The filament transformer used in connection with these new tubes is of more than passing interest There are three windings of course. The 1½ volt winding is used for amplifier circuits where UX-226 tubes are employed. A 2½ volt winding supplies the detector and a 5 volt winding supplies the power tube in the last stage.

All of the windings on the transformer shown in Fig. 12 have a center tap which may be used to take the place of the divided resistance. However, many set builders prefer to use the divided resistors even though center taps are provided.

The above is not a complete treatise on A.C. tubes but it will give the uninitiated a footing on which to begin the study of them.

ELECTRICITY MAKES SURGICAL OPERATIONS BLOODLESS



Above: Control Apparatus.

Left: The "Knife" Used in New Bloodless Surgical Operations with Electricity.

DIFFICULT operations hitherto impossible owing to loss of blood are now possible, through the use of a high frequency knife sometimes referred to as a "radio knife."

The instrument really isn't a knife at all but resembles a darning needle more than anything else. Furthermore, cutting of tissue is formed by the high frequency current and not by means of the electrode as might be believed.

The patient is placed on one electrode and the surgeon uses the other for operating purposes. When the operating electrode approaches the flesh, a small arc is formed and then the current cuts its way into the flesh clotting the blood as it goes and sealing off the blood vessels through which it cuts.

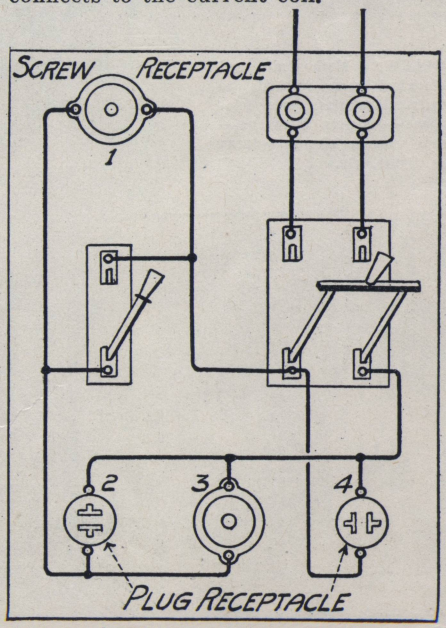
A Simple Appliance Test Panel

In the accompanying illustration is a handy test panel which will meet the needs of any test job.

The panel can be made of slate, composition slate and asbestos or it can be of ⅛ inch asbestos mounted on a ⅞ in. board backing. The size of the panel is 8 by 10 inches.

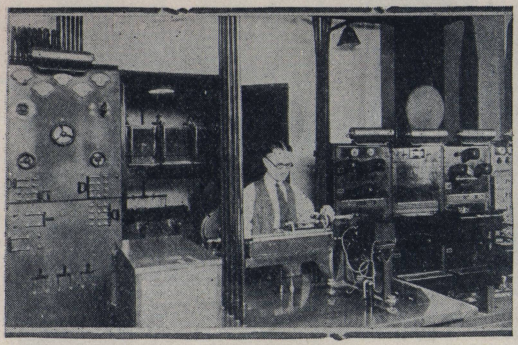
Receptacle 1 contains a lamp for making short circuit or ground tests, the appliance to be tested being connected in receptacles 2 or 3, the latter being for the occasional appliance with a non-separable plug. If it is desired to connect the appliance directly across the line after the short or ground test has been made, it is only necessary to close the single pole baby knife switch which shunts out the lamp. In case it is desired to make current readings with an ammeter, the instrument can be connected to a plug so as to take the place of the test lamp.

Receptacle 4 may be used for a soldering iron or in case it is desired to take readings with a watthour meter, receptacle 4 supplies line potential to the potential coil while receptacle 1 connects to the current coil.



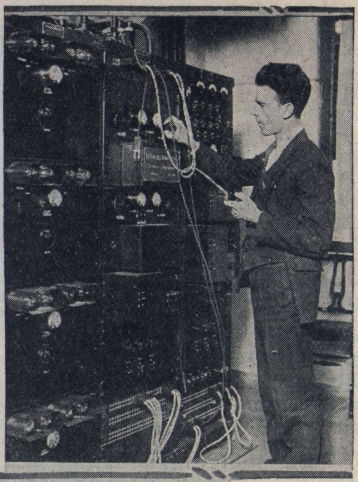
Wiring Diagram for Test Panel.

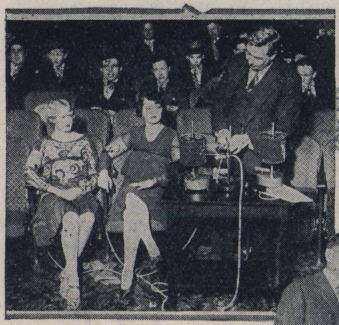
WHAT'S NEW IN ELECTRICITY

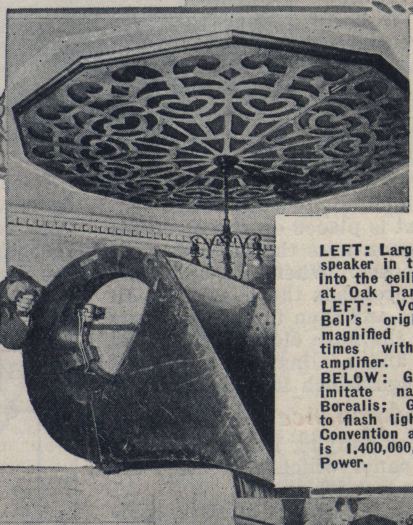


ABOVE: Motion pictures transmitted over telephone wires became a reality when ten feet of motion-picture film, were flashed 1000 miles from Chicago to New York by the telephotograph process.

BELOW: New electrical apparatus being used to test the relative emotional reactions of blondes and brunettes.







Above: Control room of the Pennsylvania Hotel's new unit system Radio, with connections in every room for the convenience of guests.

LEFT: Largest radio loud-speaker in the world, built into the ceiling of residence at Oak Park, Illinois.

LEFT: Voice over Dr. Bell's original telephone magnified thousands of times with new power amplifier.

BELOW: Getting ready to imitate nature's Aurora Borealis; Giant Projector to flash lights at Shriners Convention at Miami, Fla., is 1,400,000,000 Candle Power.

BELOW: Mechanical and electrical man responds to instructions given over telephone — answers telephone — uses vacuum cleaner — turns on lights, etc.